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A Computable General Equilibrium Model of the Nepalese Economy

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I. INTRODUCTION

The weak institutional base and poor quality of data is largely responsible for the lack of professional research in economics and other discipline in Nepal. Unless the government takes serious steps to improve the current situation, the policy making in the country will continue to take its hold on ad-hoc procedures. In this connection, multisectoral planning models and its variants were developed to assist the planner and policy makers of the country to look-after the trade-off of various policies in terms of economic benefits and costs and to provide the medium term scenario of such policies.

The first Input-Output Table, 1986/87 for Nepal was prepared by DSC(1991) under the aegis of UNIDO , which consisted 39X39 sectors. . This was further disagregated into 43x43 sectors by NPC (1992). The input-output table prepared by NPC (1992) also needs through updates and revision because of the following reasons: 1) input-output relations are too old, as it has already been ten years old; 2) the data of cost structure of agricultural crops are inadequate and based on strong assumptions; 3) cost structure data in many sector is missing, and relies largely on judgements; and 4) estimates of services sector is based on scanty evidences.

Despite these limitations, the current SAM has been prepared primarily based on the information contained in the I-O Table prepared by NPC. Moreover, other required information were collected from various publication of HMG/Nepal and Central Bank to construct SAM for Nepal. The activities in the SAM were aggregated to 15 major sectors. On the SAM database, CGE modeling of the Nepalese economy has been attempted.

1.1 Objectives

The objective of this paper is to sketch out the construction of real sector General Equilibrium Model of Nepal suitable for the general policy analysis of the country. In addition, the paper will

shed light on the income distribution aspects between the household groups: non-poor households and poor households.

1.2 Organization of the Paper

The paper is organized in four sections. Section II briefly discusses the construction of Nepalese SAM. Section III discusses the basic structure of CGE model specification and calibration. Section IV provides the simulation results.

II. SOCIAL ACCOUNTING MATRIX FOR NEPAL

The SAM provides a consistent accounting of the circular flow of incomes and expenditures in an economy for a particular year. Transactions in the economy are represented in matrix form. By convention, entries in any row of the SAM represent revenue sources, and entries in any column represent payments. Thus each cell in a Table reports a payment from a column account to a row account. Each account balances, with incomes exactly equaling expenditures such that the column sums in a SAM equal the corresponding row sums.

There are six main accounts in a SAM: Factors, Institutions, Rest of the World, Activities, Commodities and Accumulation. Each account can then be further desegregated to reflect the socio-economic structure of the economy being considered and particular policy modeling needs. The Factor account is divided into three primary factors: unskilled labour, skilled labour and capital. Institutions account is divided further among Households (non-poor and poor), Firms and Government. Activities account comprises of 15 branches of production sectors. The Commodities account is separated between domestic and export markets. Commodities account consists of 14 major groups similar to the activities, but government services has been dropped as there is absence of the market for government services. Similarly, Export market consists of 14 sectors. The Accumulation account includes private and public investment.

Distinction between "activities" and "commodities" have been made in the SAM. The account of "activities" corresponds to the producing sectors in the input-output accounts. The "commodity" accounts combine domestic supply with imports to yield total supply to the domestic market, or absorption. The separation of the "activity" and "commodity" accounts is important in the modeling framework because activities are assumed to consist of producers who are behaviorally distinct in the models. The "commodity" account corresponds to the domestic market for all products, with supplies coming from producers and imports. Note that exports are not included in the "commodity" accounts but are sold directly to the "rest of the world" by producers ("activities"). Thus exports and imports are not treated symmetrically. Furthermore, the distinction between Activities and Commodities allows more than one activity sector to produce a given commodity. This can be useful if there are two different technologies for producing the same good. The schematic SAM is described in Table 2.1.

Table 2.1: Schematic Social Accounting Matrices

Receipts	Expenditure									
	Factors	Households	Firms	Government	Rest of the World	Activities	Domestic Market	Export Market	Accumulation	Total
Factors						Value Added				GNP at Factor Cost
Households	Allocation of Income		Transfers	Government Transfer	Remittance and factor income					Has Income
Firms	Non-distributed Profit	Transfers	Transfers		Transfer from abroad					Firm Income
Government	Taxes on Factors		Taxes		Foreign Aid and other transfers to government	Indirect Taxes	Import Tariffs	Export Duties		Govt. Income
Rest of the World	Expatriation of Profits	Payments to citizen abroad	Current transfers abroad	Repayment of Government debt						Imports
Activities							Domestic Sale	Export Sale		Production
Domestic Market		Private Consumption		Government Consumption		Intermediate Inputs			Private and Public Investments	Domestic Demand
Export Market					Exports					Export Demand
Accumulation	Retained Earnings	Household Saving	Firm Savings	Government Saving	Current A/C deficit					Total Saving
Total	Factor outlay	Household Expenditure	Firm Expenditure	Government Expenditure	Foreign Exchange Earning	Production	Domestic Supply	Export Earning	Total Investment	

Table 2.2: Accounts for the Desegregated Nepal SAM

Factors	Households	Firm	Government	ROW	Activities	Commodities Domestic Market	Export Market	Accumulation
Skilled Labour Unskilled labour Capital	Non-poor HHs Poor HHs	Firm	Government	ROW	Paddy (PAD) Other food crops (OFC) Cashcrops (CCR) Livestock & Fishing (CCR) Forestry (FRY) Mining and quarring (MNQ) Manufacturing (MFG) Construction (CON) Gas, Electricity & water (GEW) Hotel and Restaurants (HTR) Transport & Communication (TCM) Whole sale and Retail Trade (WRT) Business, Real Estate and Dwelling (BRD) Government Services (GSE) Other Services (OSE)	Paddy Other food crops Cashcrops Livestock & Fishing Forestry Mining and quarrying Manufacturing Construction Gas, Electricity & water Hotel and Restaurants Transport & Communication Whole sale and Retail Trade Business, Real Estate and Dwelling Other Services	Paddy Other food crops Cashcrops Livestock & Fishing Forestry Mining and quarrying Manufacturing Construction Gas, Electricity & water Hotel and Restaurants Transport & Communication Whole sale and Retail Trade Business, Real Estate and Dwelling Other Services	Private Investment Public Investment

III. NEPALESE CGE MODEL

3.1 Introduction to Computable General Equilibrium Model (CGE)

The current CGE model is a neoclassical real side general equilibrium model. Its main features involves cost minimization by producers, utility maximization by households, perfect mobility of factors, and competitive market driving profits to zero. The model allows for detailed analysis of economic and social policy options such as impacts of tariff policy, incomes policy and anti-poverty programs, but embeds such analyses within a general equilibrium framework. This also captures relative price effects, resource allocation and other economy-wide effects.

There are four types of "agents" in the economy: households, divided into poor and non poor sub-groups, firms, the government, and the rest of the world. The model captures some of the major interactions between essential sectors of the Nepalese economy: modern and traditional, agricultural and manufacturing, importing and exporting, formal and informal, and others. Its strength is its capability to trace through the economy-wide implications of any proposed policy changes. It can identify which sector may expand and which may contract; which group in the economy may gain or lose; and assess impacts on trade patterns and inter-sectoral resource transfers. Its weakness is its traditional equilibrium structure, which assumes competitive behavior; incorporates no explicit treatment of time and in its present form, contains no monetary features and has balanced government and external sector accounts.

3.2 Specification of Model Equations

The specification of model equation follows closely that in Dervis, de Melo, and Robinson (1982) and in Condon, Dahl, and Devarajan (1987). The equations are presented in the following order: production and factor demand, industry value added functions, intermediate demands, labour market, income, expenditure and saving of households and other institutions, foreign trade, price and equilibrium conditions.

3.2.1 Production –Factor Demand

Aggregate output of the economy is produced through the Leontief technology implying a fixed ratio between value added and intermediate demand.

(1). $X_i^S = LF\ (VA_i, IC_i; IO_i, v_i)$

We have, $vi = VA_i/X_i^S$ and $io_i = IC_i / X_i^S$;

Or, $X_i^S = IC_i / io_i$ and $X_i^S = VA_i / v_i$

Together, $IC_i / io_i = VA_i / v_i$

$X_i^S = \min (IC_i / io_i , VA_i / v_i)$

3.2.2 Industry Value-added Functions

Value added is generated through the Cobb-Douglas technology with the use of primary factor labor and capital.

(2). $VA_n = CD\ (K_n, L_{ln}^D; A_n\ \alpha_{ln}) = A_n\ (L_{ln}^D)^{\alpha_{ln}}\ (K_n)^{(1-\sum\alpha_{ln})}$

The first order condition of C-D technology ensures:

MPL = (w/PVA). VA

MPK = (r/PVA). VA

Value added in the government sector is assumed to be equal to the demand of employment in the government sector.

(3). $VA_{ad} = Lad^D$

3.2.3 Intermediate Demands

Intermediate demand is a derived Leontief technology. Intermediate consumption is derived from sectoral production levels and input-output coefficients.

(4). $IC_i = LF^*(X_i^S)$

We have, $vi = VA_i/X_i^S$ and $IO_i = IC_i / X_i^S$;

Or, $X_i^s = IC_i/IO_i$ and $X_i^s = VA_i/v_i$

Together, $IC_i/IO_i = VA_i/v_i$

or, $IC_i = io_i . VA_i/v_i$

(5). $ICJ_{ij} = a_{ij} IC_j \Rightarrow a_{ij} = ICJ_{ij}/IC_j$

Demand for non-competitive imports is a Leontief technology.

(6) $ICNCI_i = noi_i . VA_i/v_i$

3.2.4 Treatment of Labor Market

Labor market takes into account the dichotomy existing in the Nepalese labour market between formal and informal sectors. Labour demand for the commercial sectors is derived from the optimizing behavior of the Cobb-Douglas technology. This is determined by the relative price of value added to the wage rate and value added generated in the sectors.

(7). $L_{ln}^D = CD^* (P_n^{VA}/w_l, VA_n)$

Labour demand for the government sector is determed by the ratio of value added to the wage rate.

(8). $L_{ad}^D = (P_{ad} X_{ad}^s - \Sigma_j P_j^c ICJ_{j\,ad} - P^{nc} ICNCI_{ad})/w$

3.2.5 Income and Savings

Household income consists of wage income, rental income , dividend and transfers.

(9). $Y_h = \Sigma_l \gamma_{h\,l\,W\,l} \Sigma_i L_{li}^D + \phi \lambda_h \Sigma_n R_n K_n + Div_h + eT_{rh} + T_{gh}$

Firms capital income is defined as the share of non-household rental income.

(10). $Y_k = (1-\lambda)\Sigma_n R_n K_n$

Dividend is assumed as a fixed rate of the firms capital income

(11). $DIV_h = dvr_h Yk$

Household saving is defined as a fixed percent of the disposable income of the household.

(12). $S_H = mps\ YD_H$

Disposable income is derived as household income net of income taxes.

(13). $YD_H = (1-\chi . ty)Y_H$

Firm income consists of firms capital income, government transfers to firms evaluated at producer prices and rest of the world transfer to firms at local currency.

(14). $Y_F = YK + PINDEX\ T_{GF} + e.\ T_{RF}$

Firm saving is derived through deducting the capital taxes, dividend and transfer to the rest of the world from the firm's total income.

(15). $S_F = Y_F - tk\ YK - DIV - T_{FR}$

Government income comprises of taxes from households, capital tax of the firms, production taxes, transfer from rest of the world to government, import duty and export tariff.

(16). $Y_G = \sum_h (\chi\ ty_h\ YH_h) + tk\ YK + \sum i\ TXS_i + eTRG$
$+ \sum_n TXM_n + \sum_n TXE_n + \sum i\ TMNIi$

Indirect taxes is equal to the tax revenue generated from total output at producer price.

(17). $TXS_i = tx_i\ P_i\ X_i^S$

Import duty is equal to tariff collected at the domestic prices.

(18). $TXM_n = tm_n\ e\ P_n^{WM}\ M_n$

Export tariff is equal to export tariff collected at domestic prices.

(19). $TXE_n = te_n\ P_n^E\ EX_n$

(20). $TMNI_i = tmi_i\ PC^{NW}{}_i\ (e.ICNCI_i)$

Government saving is equal to government income less government transfer less total government consumption.

(21). $S_G = Y_G - PINDEX\ T_{GF} - CT_G - TGR - \sum_h TGH_h$

3.2.6 Demand

Total household consumption is equal to disposable income of the houreholds less saving of the households.

(22). $CTH_h = YDH_h - SH_h$

Consumers problem is solved with the maximization of utilities subject to the budget constraint. Consumer's problem is solved following Linear Expenditure System, the detail derivation is provided in the Appendix1.

Household consumption is defined as the volume of consumption that the houshold sector consumes.

(23). $CH_{hi} = MINI_{hi} + \beta_{hi}^{C} (CTH_h - \sum_j P_j^{C} MINI_{hj}) / .P_i^{C}$

Government consumption is defined as the volume of consumption that the government sector consumes.

(24). $CG_i = \beta_i^{G} CT_G / P_i^{C}$

Total consumption of good i is a volume measure comprising of household and government consumption.

(25). $C_i = \sum_h CH_{h\,i} + CG_i$

Intermediate demand of good i is derived from the input-output relations and intermediate consumption of good i.

(26). $INTD_i = \sum_j a_{ij} IC_j$

Investment is also a volume measure determined by the share of good i in the total volume of investment, normalized through composite price index. Investment demand between the public and private sector is separately estimated.

(27). $INV_{ki} = \beta_{ki}^{I} IT_k / P_i^{C}$

3.2.7 Foreign Trade

The standard small-country assumption in simple commodity trade models is that the world price is fixed (i.e. that the country modeled is a price-taker) and that the domestic good is a perfect substitute for the internationally traded commodity, so that the law of one price holds. Given the high level of aggregation in an economy wide model, the assumption of perfect substitutability between domestic goods and international traded goods is not reasonable for most sectors. Thus, for importables, an alternative formulation, first proposed by Armington (1969) , is used. First a composite commodity (Q_i) is defined as a CES function of imported

goods (Mi) and domestically produced commodities (D_i). This can be formulated either as a maximization or as a minimization problem. The first order condition of the cost minimization problem expresses the ratio of imported goods to domestically produced goods as a function of relative price of imported and domestically produced goods, where $\sigma_i = 1/(1+\rho_i)$ is the "trade substitution" elasticity (see Appendix II for derivation). The larger the value for σ_i, the greater the sensitivity of the share of imports in total supply to price changes. In the limit, with σ_i equals to infinity (i.e. imports and domestic goods are perfect substitute), P^D must equal P^M if imports and domestic production are both non-zero.

The Nepal's demand for imports is assumed to be too small to affect world prices, so the world price of imports expressed in foreign currency(P^{WM}) is fixed exogenously. The domestic price of imports is determined by $P_n^M=(1+tm_n)eP_n^{WM}$. Likewise, the domestic FOB price of exports (P_n^E) is equal to the exogenous world FOB price in US$ (P^{WE}) converted to domestic currency , less export taxes: $P_n^E =eP_n^{WE}/(1+ te)$. The composite commodity Qn is a CES function of domestic and imported commodity.

(28). $Q_n = CES(D_n, M_n; b_n^s, \delta_n^s, \rho_n^s)$

Government demand of the composite commodity is simply the government services or output.

(29). $Qad= Xad$

Import demand function is derived from the cost minimization of the CES.

(30). $M_n = CES^*(P_n^M/P_n^D, D_n; \sigma_n^s)$

Analogous to import goods, export goods and goods produced and consumed domestically may not be perfect substitute because of the relatively high level of aggregation in the model . Following Condon, Dahl and Devarajan (1987), a constant elasticity of transformation (CET) function between domestic and export market is used. Total output is defined as the constant elasticity of transformation for domestic and export markets.

(31). $X_ns =CET(EX_n, D_n; b_n^T, \delta_n^T, \rho_n^T)$

Export demand is derived from the CET and is determined by the relative price of export to domestic price index, domestic output level and degree of transformation between domestic and export markets.

(32). $EX_n = CET*(P_n^E/P_n^D, D_n; \sigma_n^T)$

Current account balance is derived as the import (c.i.f.) plus transfer payments from the rest of the world less export (fob) less transfer from the rest of the world to households and less transfer from the rest of the world to government. The current account deficit is encountered if there is excess demand of goods and services.

(33). $CAB = (1/e)TGR + \sum_n P_n^{WM} M_n + \sum_i P^{NCW}{}_i ICNCI_i - \sum_h TRH_h - TRF - TRG - \sum_n P_n^{WE} EX_n$

3.2.8 Price

Producer Price is a weighted average of price of domestically produced and consumed commodities and domestic price of exports, with the volume weights being the ratio of local demand for domestically produced goods i to total production and ratio of exports (fob) to total production, adjusted for the indirect taxes.

(34). $P_n = [(D_n/X_n^S) P_n^D + (EX_n/X_n^S) P_n^E] / (1+tx_i)$

Price of value added is the ratio of total output less intermediate consumption to the value added in the sector.

(35). $P_n^{VA} = (P_n X_n^S - \sum_j P_j^C ICJ_{jn}) - PN^C{}_n ICNCI_n / VA_n$

Domestic price of imports is equal to world prices of imports evaluated at real exchange rate inclusive of import tariffs.

(36). $P_n^M = (1+tm_n) e P_n^{WM}$

Domestic price of exports is equal to world price of exports evaluated at real exchange rate and adjusted for the export taxes.

(37). $P_n^E = eP_n^{WE}/(1+te_n)$

Rental rates of capital are defined as the ratio of operating surplus to the capital stock of the sector concerned.

(38). $R_n = (P_n^{va} VA_n - \sum_h W_h L_{ln}^D) / K_n$

Composite price P_n^C is defined as the weighted average price of domestic and import prices, the weights being the share of domestic and imported output in the composite commodity.

(39). $P_n^C = (D_n/Q_n)P_n^D + (M_n/Q_n)P_n^M$

Price of the non-competitive imports is equal to the tariff on non-competitive imports multiplied by the world price of non-competive imports times exchange rate.

(40) $P_i^{CN} = (1+tmi_i)P_i^{CNW} e$

Price of the government services is the domestic prices of such services.

(41) $P_{ad}^C = P_{ad}$

Producer Price Index is the weighted average domestic prices, the weights being the share of goods in the total domestic production.

(42). $Pindex = \sum_i \beta_i^X P_i$

3.2.9 Equilibrium

In equilibrium, total investment is equal to domestic saving plus current account balance at domestic currency.

(43). $IT_p = L_i^D + \sum SH_h + psS_F$

(44) $IT_g = (1\text{-}ps).\ SF + SG + e.\ CAB$

Composite commodity Q is equal to consumption demand, intermediate demand and investment demand.

(45). $Q_i = C_i + INTD_i + \sum_k INV_{ki}$

Labor supply is equal to labor demand.

(46). $L_{li}^S = U_{li} + \sum_i L_{li}^D$

(47) $u_i = U_{li} / L_{li}^S$

3.3 Summary of Model Specifications

A. Equations Number of Equations

A.1. Production –Factor Demand

A.1.1 Production

(1). $X_i^S = LF\ (VA_i, IC_i; IO_i, v_i)$ 15

(2). $VA_n = CD\ (K_n, L_{ln}^D; A_n\ \alpha_{ln}) = A_n\ (L_{ln}^D)\ \alpha_{ln}\ (K_n)^{(1-\sum\alpha_{ln})}$ 14

(3). $VA_{ad} = L_{ad}^D$ 1

(4). $IC_i = LF^*(X_i^S)$ 15

(5). $ICJ_{ij} = a_{ij}\ IC_j \Rightarrow a_{ij} = ICJ_{ij}\ /Ic_j$ 225

(6) $ICNCI_i = noi_i\ VA_i/v_i$ 15

A.1.2 Labour Market

(7). $L_{ln}^D = CD^*\ (P_n^{VA}/w_l, VA_n)$ 30

(8). $L_{ad}^D = (P_{ad}\ X_{ad}^s - \Sigma_j\ P_j^c\ ICJ_{j\ ad} - P^{nc}\ ICNCI_{ad})/w$ 1

A.2. Income and Savings

(9). $Y_h = \sum_l\ \gamma_{h\,l}\ W_l \sum_i L_{li}^D + \phi\ \lambda_h\ \sum_n R_n\ K_n + Div_h + eT_{rh} + T_{gh}$ 2

(10). $Y_k = (1-\lambda)\sum_n R_n\ K_n$ 1

(11). $DIV_h = dvr_h\ Yk$ 2

(12). $S_H = mps\ YD_H$ 2

(13). $YD_H = (1-\chi.\ ty)Y_H$ 2

(14). $Y_F = YK + PINDEX\ T_{GF} + e.\ T_{RF}$ 1

(15). $S_F = Y_F - tk\ YK - DIV - T_{FR}$ 1

(16). $Y_G = \sum_h (\chi\ ty_h\ YH_h) + tk\ Y_K + \sum i\ TXS_i + eT_{RG} + \sum_n TXM_n + \sum_n TXE_n + \sum i\ TMNIi$ 1

(17). $TXS_i = tx_i\ P_i\ X_i^S$ 15

(18). $TXM_n = tm_n\ e\ P_n^{WM}\ M_n$ 14

(19). $TXE_n = te_n\ P_n^E\ EX_n$ 15

(20). $TMNI_i = tmi_i\ PC^{NW}{}_i\ (e.ICNCI_i)$ 15

(21). $S_G = Y_G - PINDEX\ T_{GF} - CT_G - T_{GR} - \sum_h T_{GH\,h}$ 1

A.3. Demand

(22). $CTH_h = YDH_h - SH_h$ 2

(23). $CH_{hi} = MINI_{hi} + \beta_{hi}^C\ (CTH_h - \sum_j P_j^C\ MINI_{hj})\ /\ .P_i^C$ 30

(24). $CG_i = \beta_i^G\ CT_G/P_i^C$ 1

(25). $C_i = \sum_h CH_{h\,i} + CG_i$ 15

(26). $INTD_i = \sum_j a_{ij}\ IC_j$ 15

(27). $INV_{ki} = \beta_{ki}^I\ IT_k/P_i^C$ 30

A.4. Foreign Trade

(28). $X_n s = CET(EX_n, D_n; b_n^T, \delta_n^T, \rho_n^T)$ 14

(29). $EX_n = CET^*(P_n^E/P_n^D, D_n; \sigma_n^T)$ 14

(30). $Q_n = CES(D_n, M_n; b_n^s, \delta_n^s, \rho_n^s)$ 14

(31).	$Qad = Xad$	1	
(32).	$M_n = CES^*(P_n^M/P_n^D, D_n; \sigma_n^s)$		14
(33).	$CAB = (1/e)T_{GR} + \sum_n P_n^{WM} M_n + \sum_i P^{NCW}{}_i ICNCI_i - \sum_h T_{RHh} - TRF - TRG - \sum_n P_n^{WE} Ex_n$	1	
A.5.	**Prices**		
(34).	$P_n = [(D_n/X_n^S) P_n^D + (EX_n/X_n^S) P_n^E] / (1+tx_i)$	14	
(35).	$P_n^{VA} = (P_n X_n^S - \sum_j P_j^C ICJ_{jn}) - PN^C{}_n ICNCI_n / Va_n$		14
(36).	$P_n^M = (1+tm_n) e P_n^{WM}$	14	
(37).	$P_n^E = e P_n^{WE} / (1+te_n)$	14	
(38).	$R_n = (P_n^{va} VA_n - \sum_h W_h L_{ln}^D) / K_n$	14	
(39).	$P_n^C = (D_n/Q_n) P_n^D + (M_n/Q_n) P_n^M$	14	
(40)	$P_i^{CN} = (1+tmi_i) P_i^{CNW} e$	14	
(41)	$P_{ad}^C = P_{ad}$	1	
(42).	$Pindex = \sum_i \beta_i^X P_i$	1	
A.6.	**Equilibrium Condition**		
(43).	$IT_p = L_i^D + \sum SH_h + psS_F$	14	
(44)	$IT_g = (1-ps).\ SF + SG + e.\ CAB$	14	
(45).	$Q_i = C_i + INTD_i + \sum_k INV_{ki}$	15	
(49).	$L_{li}^S = U_{li} + \sum_i L_{li}^D$	30	
(50)	$u_i = U_{li} / L_{li}^S$		

B. Endogenous Varriables

	Number of Endogenous Variables
X_i^s : Branch i's production	15
VA_i : Branch i's value added	15
L_{li}^D : Branch i's labour demand by category 1	30
Y_h^H: Total household income by h households	2
YK: Firm capital income	1
DIV_h: Dividend distributed to household h	2
S_h^H: Household savings	2
YD_H: Household disposable income	2
Y_F: Firm total income	1
S_F: Firm saving	1
Y_G : Government revenue	1
$TXS_{i:}$ Indirect taxes	14
TXM_n: Revenue from import duties	14
TXE_n: Revenue from export tariffs	14
S_G: Government saving	1
CT_H : Total Household consumption	1
CH_{hi} : Household consumption of good i by h households	30
CG_i : Public consumption of good i	14
C_i : Consumption of good i (volume)	14
IT: Total investment (value)	1

INV_i:	Consumption of good i for investment uses (volume)	28
IC_i :	Total intermediate consumption by branch	15
ICJ_{ij} :	Intermediate Consumption of good j by branch i	225
$INTD_i$:	Intermediate demand of good i (volume)	15
D_n:	Local demand for domestically produced goods (volume)	14
EX_n:	Export (FOB volume)	14
M_n:	Imports (CIF volume)	14
Q_i:	Domestic demand for composite good i	15
P_i:	Producer Price	15
P_n^D:	Price of domestically produced and consumed goods	14
P_i^C:	Price of composite goods	15
P_n^{VA} :	Value added price	14
P_n^E:	Domestic price of exports	14
P_n^M:	Domestic price of imports	14
R_n:	Rate of return on capital in branch n	14
W_s:	Wage rate by skill categories	2
CAB:	Current account balance (in foreign prices)	1

C. Exogenous Variables

		Number of Exogenous Variables
K_n:	Branch n's capital stock	14
L_l^S :	Total labor supply of cateogy l	2
P_n^{WM} :	World price of imports (in foreign currency)	14
P_n^{WE} :	World Price of Exports (in foreign curency)	14
PINDEX:	Producer price index	1
CT_G:	Total public consumption (value)	1
T_{GF}:	Government transfer payments to firms (volume)	1
T_{RH} :	Foreign transfer payments to households by category h	2
T_{FR}:	Firms transfer payments to the rest of the world	1
e:	Exchange rate (NRs per US dollar)	1

D. Parameters

A_n:	Cobb-Douglas scale coefficients
α_n:	Cobb-Douglas elasticities
λ:	Household share of Capital Income
dvr_h:	Dividend rate of households h
mps:	Household marginal propensity to save
ty_h:	Household income tax rate by category of household h
tk:	Capital income tax rate

tx_i: Indirect tax rate
tm_n: Import duty rate
$tmi_{i:}$ Duty on Intermediate Imports
te_n: Export tax rate
β_i^G: Share of good i in public consumption
β_i^C: Share of good i in household consumption
β_i^I: Share of good i in total investment
β_i^X: Branch i's share in total production
a_{ij}: Input-output coefficients
io_i: Leontief technical coefficients (domestic intermediate consumption)
$noi_{i:}$ Leontief technical Coefficients (intermediate imports)
v_i: Leontief technical Coefficients (value added)
b_n^T: CET scale parameter
δ_n^T: CET distributive share
ρ_n^T: CET transformation parameter
σ_n^T: CET elasticity of transformation
b_n^s: CES scale parameter
δ_n^s: CES distributive share
ρ_n^s: CES substitution parameter
σ_n^s: CES elasticity of substitution

E. Functions

CD: Cobb-Douglas function
CD*: Function derived from Cobb-Douglas
LF: Leontief function
LF*: Function derived from Leontief
CET: Constant elasticity of transformation
CET*: Function derived from CET
CES: Constant Elasticity of Substitution
CES*: Function derived from CES
LES: Linear Expenditure System

F. Sets

$i \in I$ = { N, ad } All sectors
$n \in N$ = { PAD, OFC, OCC, LFS, FOR,
MNQ, MFG, GEW, TRC, WRT, PSE, GSE: Commercial Sectors }
AGR = { PAD, OFC, OCC, LFS, FOR}
$AGR \in N$
ad: {GSE: Non-commercial sectors}

3.4 Model Closure

All the model specifications are neoclassical except labour market, where equilibrium is attained at less than full employment. Therefore, labour market follows Keynesian closure.

3.5 Base Year Data and Calibration of Parameters

The base period data used for the model are contained in SAM. The SAM as constructed also satisfies the various equilibrium conditions implied by the model structure we use. Aggregate supply of each good equals aggregate demand. Aggregate supply includes both domestic production and imports, while aggregate demand includes both intermediate and final demands. Final demands include private consumption expenditures, government expenditures, capital formation and exports. In addition, industry earn nominal economic profits; i.e. total receipts from sales equal total expenditures; total sales include payments for intermediate demands, final demands, and net trades; total cost of production include cost of intermediate input, payments to primary factors and taxes. Taxes paid by the production sector include the production value added-tax, import tariffs and export duties.

The base period equilibrium data set must be micro-consistent and satisfy all equilibrium condition and properties of the model given in equations (1) to (47): market clearance for all goods and factors; all fifteen sectors earn zero profits; budget balance holds for all household groups; and government budget balance. The SAM once constructed thus provides a base-period equilibrium data set, which can be used in the numerical implementation of the general equilibrium model described above, since calibration of the model to the data in the SAM involves base data consistent with the equilibrium structure of the model.

Calibration of the CGE model to the SAM requires the determination of parameter values for the various behavioral functions in the model such that the model reproduces the benchmark data set as equilibrium solution. Calibration of Cobb-Douglas functions is relatively straight

forward. Elasticities in the Cobb-Douglas function can be determined simply from the input share of the factors. However, the procedure used to determine the share and other parameters in the CES and CET functions through calibration are more complex, and needs values for elasticities of substitution and elasticity of transformation, respectively either from econometric studies or from literature search. The substitution parameters ((σ_i) used in the aggregation of imported and domestic goods determine imports demand elasticities given the share of domestically produced goods in total consumption. Similarly, the transformation parameters (Ψ i) used in the aggregation of exported and domestic goods determine export supply elasticities given the share of domestic sales in total sales of domestically produced goods. A high value of σi or Ψi indicates goods are close substitutes. The values of various parameters used for the calibration are provided in the Tables 3.1 to 3.5.

Table 3.1: Parameters of Linear Expenditure System in Consumption

Sectors	EPSILON		BETA_CA		BETA_C		MINI	
	Income Elasticities		Average Budget Share		Marginal Budget Share		Floor Consumption Level	
	Non-Poor	Poor	Non-Poor	Poor	Non-Poor	Poor	Non-Poor	Poor
PAD	1.05	0.95	0.227	0.138	0.244	0.222	4477	2973
OFC	0.8	0.4	0.113	0.163	0.092	0.11	2305	3923
CCR	0.6	0.4	0.121	0.144	0.074	0.097	2593	3472
LNF	1.03	0.8	0.161	0.073	0.169	0.099	3216	1641
FRY	0.95	0.44	0.04	0.094	0.039	0.07	805	2268
MNQ	0.92	0.43	0.003	0.002	0.003	0.001	55	40
MFG	1.19	1.2	0.239	0.147	0.29	0.299	4100	2672
CON	1.19	1.2						
GEW	1.19	1.2	0.016	0.01	0.02	0.021	313	206
HTR	1.19	1.38	0.0003	0.0001	0.0004	0.0004	6	3
TCM	1.19	1.38	0.001	0.0008	0.002	0.002	26	16
WRT	1.19	1.38	0.002	0.001	0.003	0.003	48	29
BRD	1.19	1.38	0.045	0.027	0.055	0.064	871	536
GSE	1.19	1.12	0.0002	0.0001	0.0002	0.0002	4	2
OSE	1.19	1.38	0.008	0.005	0.009	0.01	146	90

Note: Frisch parameter : H1=--5.5, H2= -5.0

Table 3.2: Indirect Taxes and Tariff Rates

Sectors	Indirect Tax	Import Tariff	Non-competitive Import Tariff	Export Tax
PAD	0.019	0.167		
OFC	0.035	0.172		
CCR	0.029	0.081		0.01
LNF	0.01	0.071		0.011
FRY	0.027		0.583	
MNQ	0.003	0.179		
MFG	0.121	0.11	0.118	0.011
CON	0.013		0.204	
GEW	0.008	0.178	0.012	
HTR	0.051		0.015	0.011
TCM	-0.0002	0.076	0.126	0.011
WRT	0.0005	0.043		0.011
BRD	0.005		0.311	
GSE				
OSE	0.002		0.004	

Table 3.3: Cobb-Douglas Production Function on Primary Factors

Sectors	A	ALPHA	ALPHAQ
PAD	1.672	0.425	0.033
OFC	1.585	0.561	0.054
CCR	1.727	0.35	0.037
LNF	1.571	0.478	0.022
FRY	1.717	0.309	0.034
MNQ	1.641	0.33	0.02
MFG	1.861	0.191	0.082
CON	1.739	0.359	0.04
GEW	1.983	0.22	0.106
HTR	1.892	0.291	0.073
TCM	2.201	0.272	0.167
WRT	1.406	0.058	0.038
BRD	2.168	0.282	0.155
GSE			
OSE	2.101	0.448	0.346

Table 3.4: Constant Elasticity of Transformation of Domestic and Export Goods

Sectors	B-T	DELTA-T	RHO_T	SIGMA-T
PAD	51.71	1	2.25	0.8
OFC	34.581	1	2.25	0.8
CCR	5.04	0.953	1.909	1.1
LNF	9.702	0.994	2.25	0.8
FRY	41.113	1	2.25	0.8
MNQ		1	3.5	0.4
MFG	2.68	0.859	2.25	0.8
CON		1	2.25	0.8
GEW		1	2.25	0.8
HTR	2.159	0.219	3.5	0.4
TCM	2.162	0.71	2.25	0.8
WRT	2.549	0.835	2.25	0.8
BRD		1	2.111	0.9
GSE				0.8
OSE	18.979	1	1	0.6

Table 3.5: Constant Elasticity of substitution between Imported and Domestic Goods

Sectors	B-S	DELTA-S	RHO_S	SIGMA-S
PAD	1.003	0	1	0.5
OFC	1.025	0.001	0.429	0.7
CCR	1.036	0	4	0.2
LNF	1.058	0.006	0.25	0.8
FRY	1.451		1.5	0.4
MNQ		0.132	-0.091	1.1
MFG	1.817	0.232	0.667	0.6
CON			0.25	0.8
GEW	1.057	0.0002	1.5	0.4
HTR			-0.091	1.1
TCM	1.284	0.031	0.667	0.6
WRT	1.125	0.004	1	0.5
BRD			0.25	0.8
GSE				0.7
OSE			2.333	0.3

Many of the parameters of the model, such as the tables of input-output coefficients (io), distributions of returns to labor and capital by household type, derive directly from the benchmark data. Other coefficients are implicit in the benchmark data, given the functional

forms used in the model equation and other parameters. These coefficients are calibrated so that the model produces the base SAM when no exogenous variables are changed. One other major parameter, the marginal propensity to save for households, can be chosen independently of the SAM. In the simulation runs for this paper, however, the marginal propensity to save is set equal to the average savings rate from the SAM.

Following Harberger (1962), unit convention is used to separate the benchmark equilibrium data for the SAM into separate price and quantity observation. For example, by assuming the net-of –tax price of labour to be one in the bench mark equilibrium, the quantity of labour demanded sector i is determined directly by the value added data on labour use in sector i. With this separation of value observations in the SAM into price and quantity observations complete, model calibration is implemented for the CES functions in the ways described in Mansur and Whalley (1984) using elasticity parameters from the literature search.

IV. SIMULATION RESULTS

4.1 Discussion of Result

The following simulation runs were made to know the economy-wide effects of policy changes.

Simulation 1: Reducing the import duty across the board by 25 % on the competitive imports and elimination of input tariff to zero.

Simulation 2: Currency depreciation by 20 %.

Simulation 3: Increasing skilled wages by 20 %.

Simulation 1: Reduction of import duty across the board by 25% and elimination of duty on intermediate imports.

Reduction in import duty in both competitive imports and intermediate imports is a major part of trade policy reforms, which Nepal has also taken between 1987-95 during the stabilization, structural adjustment and enhanced structural adjustment program adopted in Nepal. This policy is expected to correct the relative prices and improves resource allocation and improves competitiveness of domestic production. As expected the import demand increase in agriculture, mining and gas, electricity and water. However, the increase in import demand are very low and this may be due to inelastic imports demand in most sectors. Furthermore, to have the good simulation results, this policy should come in combination with exchange rate depreciation. Because of this reason, simulation results in increased import demand are not seen as they are expected to be. The manufacturing witnessed slight decline in import demand. Similarly, transport and communication and wholesale and retail trade import demand declined by 2 percent and 8 percentage points respectively.

In the export front, all the sector response positively, however the elasticities are low. The revenue from export duty increases significantly in the manufacturing, hotel and restaurants, transport and communication and wholesale and retail trade sector.

The effect on the government income is negative, government income reduces by 9.8 percentage points. This is because, the policy reduces the revenue from import tariffs nearly proportionately in all sector except transport and communication and wholesale and retail trade, where import revenue loss is more than proportionate.

The effect of the policies in the labor market are strongly felt in the reduction of qualified labor in construction and wholesale and retail trade whereas increased demand for qualified labor was witnessed in hotel and restaurants. The effect of the policies in the demand for unqualified labor is quite low in agriculture sector; whereas construction, wholesale and retail trade witnesses 5.7 percent and 12.3 percent reduction in labor demand respectively. Similarly, hotel and restaurant sector experiences increased demand for unqualified labor.

Simulation 2: Currency depreciation by 20 percent

Depreciation of currency by 20 percent increases import prices by 20 percent for the imports while Nepalese export price will be lower by 20 percent As a result, imports become dearer and are expected to decline while exports are expected to increase.

The effect of policy in the import front are as expected, but because of the inelasticity of import demand in most of the sector, decrease in import demand is quite weaker. However, import demand in the wholesale and retail trade increases despite the depreciation of currency. In the export front, all the sector experience significant growth in export due to higher competitiveness except wholesale and retail trade. The effect of depreciation on government saving is quite significant, it decreases by 190%. In the indirect taxes front, the effect is positive. This must be through increased export duty revenue due to beneficial effects on exports.

Simulation 3: Increasing skilled wages by 20%.

Increase in skilled wages by 20% will affect the labor demand in the sectors which are skill intensive to skilled wages. The effect will depend on the share of skilled employees to total employment in the sector and degree of substitutability (elasticity of substitution between skilled and unskilled labor). As skilled labor become too expensive to hire, firms try to substitute unskilled labor to skilled labor. As a consequence, demand for unskilled labor increases.

Increasing the skilled wages by 20 percent means relative price of unskilled labor declines in relative terms and thus increases the demand for unskilled labor where there is possibility of substitution of skilled labour by unskilled labour. Demand for unskilled labor increases in all the sectors except mining and quarrying, hotel and restaurants, transport and communication.

Labor demand in the agriculture sector increases slightly, between one to two percentage points, whereas manufacturing, construction, forestry, gas and electricity, business, real-estate and dwelling all experience increased labor demand, but most noticeable increase are witnessed in the wholesale and retail trade.

Qualified labor demand in all sector declines significantly, but the elasticity is less than one in all sector except hotel and restaurants, where it is more than one. On the other hand, labor demand for unqualified labor increases in most of the sectors.

4.2 Welfare Implications of the Simulation

In order to evaluate the welfare effects of the policies to non-poor and poor households equivalent variations were computed using the following formula:

$$EV = \mu\ (p^o; p', y'\ ) - \mu\ (p^o; p^o, y^o\ ) = \mu\ (p^o\ ;\ p', y'\ ) - y^o$$

Where, $\mu\ (p^o; p', y'\ )$ and $\mu\ (P^o; P^o, Y^o\ )$ are the new and old income, respectively at base year prices.

Table 4.1: Equivalent Variation Under Different Simulation for Non-poor and Poor Households

	Non-poor Households	Poor–Households
Simulation 1	21.008	218.017
Simulation 2	-9.756	19.926
Simulation 3	367.341	-340.037

This result shows that reduction of tariffs in competitive imports and elimination of import duties on intermediate inputs increases the welfare of the poor households compared to the non-poor. The devaluation hurts non-poor households and slightly benefits poor households. The increase in wages of the skilled labour and public servants increases the welfare of non-poor but hurts poor household very much.

Table 4.2: Policy Simulation

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
A. Price				
WAGE	0.5	-0.006	0.222	-1.766
RENTAL R				
PAD	1	0.005	-0.174	0.283
OFC	1	0.009	-0.322	0.053
CCR	1	0.092	2.74	-0.169
LNF	1	-0.341	2.596	-0.019
FRY	1	-1.644	-6.555	2.456
MNQ	1	-0.438	10.735	-2.817
MFG	1	0.814	12.913	0.484
CON	1	-5.725	13.988	-0.377
GEW	1	0.235	3.31	1.848
HTR	1	2.17	13.781	-9.19
TCM	1	1.308	13.436	-2.527
WRT	1	-12.337	87.978	40.501
BRD	1	0.021	3.329	3.443
GSE	1			
OSE	1	-0.007	1.454	3.487
PVA				
PAD	1			
OFC	1			
CCR	1	0.054	1.752	-0.057
LNF	1	-0.174	1.397	-0.461
FRY	1	-1.085	-4.291	1.685
MNQ	1	-0.287	6.931	-2.059
MFG	1	0.59	9.276	1.518
CON	1	-3.483	8.272	-0.14
GEW	1	0.157	2.269	2.819
HTR	1	1.372	8.623	-5.168
TCM	1	0.73	7.389	1.13
WRT	1	-11.221	76.942	36.801
BRD	1	0.01	1.925	4.317
GSE	1			
OSE	1	-0.004	0.398	6.416
P				
PAD	1	-0.72	4.277	1.741
OFC	1	-0.783	4.796	1.85
CCR	1	-0.376	3.432	0.9
LNF	1	-0.474	2.925	0.36
FRY	1	-0.936	2.253	1.421
MNQ	1	-1.433	8.813	1.782
MFG	1	-2.78	10.243	1.356

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
CON	1	-4.129	9.71	0.258
GEW	1	-0.655	5.939	2.93
HTR	1	-0.641	14.516	-1.331
TCM	1	-2.768	13.52	4.078
WRT	1	-8.351	52.829	25.78
BRD	1	-0.631	3.258	4.012
GSE	1	-0.665	4.676	13.358
OSE	1	-1.003	8.853	3.638
PD				
PAD	1.019	-0.72	4.263	1.743
OFC	1.035	-0.784	4.77	1.853
CCR	1.03	-0.389	2.809	0.931
LNF	1.027	-0.482	2.619	0.366
FRY	1.027	-0.937	2.231	1.422
MNQ	1.003	-1.433	8.813	1.782
MFG	1.146	-3.301	8.362	1.606
CON	1.013	-4.129	9.71	0.258
GEW	1.008	-0.655	5.939	2.93
HTR	1.131	-1.541	6.655	-3.206
TCM	1	-4.147	10.238	6.029
WRT	1.001	-10.733	60.825	32.092
BRD	1.005	-0.631	3.258	4.012
GSE				
OSE	1.002	-1.012	8.749	3.671
PC				
PAD	1.019	-0.726	4.292	1.739
OFC	1.036	-0.808	4.89	1.837
CCR	1.031	-0.431	3.298	0.904
LNF	1.011	-0.5	2.876	0.36
FRY	1.027	4.933	21.367	-5.184
MNQ	1.02	-1.698	9.989	1.584
MFG	1.134	-3.032	12.069	1.082
CON	1.013	-4.129	9.71	0.258
GEW	1.013	-0.768	6.432	2.825
HTR	1.131	-1.541	6.655	-3.206
TCM	1.008	-3.876	11.333	5.326
WRT	1.003	-10.163	58.197	30.033
BRD	1.005	-0.631	3.258	4.012
GSE	1	-0.655	4.676	13.358
OSE	1.002	-1.012	8.749	3.671
PM				
PAD	1.167	-3.571	20	
OFC	1.172	-3.676	20	
CCR	1.081	-1.863	20	

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
LNF	1.071	-1.647	20	
FRY	1			
MNQ	1.179	-3.804	20	
MFG	1.11	-2.472	20	
CON	1			
GEW	1.178	-3.774	20	
HTR	1			
TCM	1.076	-1.773	20	
WRT	1.043	-1.042	20	
BRD	1			
GSE				
OSE	1			
PWM				
PAD	1			
OFC	1			
CCR	1			
LNF	1			
FRY	1			
MNQ	1			
MFG	1			
CON	1			
GEW	1			
HTR	1			
TCM	1			
WRT	1			
BRD	1			
GSE	1			
OSE	1			
PE				
PAD	1		20	
OFC	1		20	
CCR	1		20	
LNF	1		20	
FRY	1		20	
MNQ	1		20	
MFG	1		20	
CON	1		20	
GEW	1		20	
HTR	1		20	
TCM	1		20	
WRT	1		20	
BRD	1		20	

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
GSE	1		20	
OSE	1		20	
PWE				
PAD	1			
OFC	1			
CCR	1.01			
LNF	1.011			
FRY	1			
MNQ	1			
MFG	1.011			
CON	1			
GEW	1			
HTR	1.011			
TCM	1.011			
WRT	1.011			
BRD	1			
GSE				
OSE	1			
e	1		20	
PINDEX	1	-1.731	8.606	3.463
B. PRODUCTION				
VA				
PAD	7553	0.005	-0.174	0.283
OFC	4658	0.009	-0.322	0.053
CCR	6203	0.038	0.972	-0.112
LNF	9124	-0.168	1.182	0.444
FRY	2909	-0.565	-2.366	0.759
MNQ	100	-0.152	3.558	-0.774
MFG	3156	0.223	3.329	-1.019
CON	5040	-2.322	5.279	-0.238
GEW	414	0.078	1.018	-0.944
HTR	667	0.787	4.748	-4.24
TCM	3594	0.574	5.631	-3.616
WRT	2238	-1.257	6.237	2.705
BRD	4715	0.011	1.378	-0.838
GSE	4209	0.667	-4.441	-11.742
OSE	867	-0.003	1.052	-2.753
XS				
PAD	11097	0.005	-0.174	0.283
OFC	7863	0.009	-0.322	0.053
CCR	8620	0.038	0.972	-0.112

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
LNF	10545	-0.168	1.182	0.444
FRY	4105	-0.565	-2.366	0.759
MNQ	370	-0.152	3.558	-0.774
MFG	12182	0.223	3.329	-1.019
CON	6675	-2.322	5.279	-0.238
GEW	1412	0.078	1.018	-0.944
HTR	1976	0.787	4.748	-4.24
TCM	8098	0.574	5.631	-3.616
WRT	4286	-1.257	6.237	2.705
BRD	5725	0.011	1.378	-0.838
GSE	6596	0.667	-4.441	-11.742
OSE	2111	-0.003	1.052	-2.753
C. FACTOR				
K				
PAD	4096			
OFC	1797			
CCR	3806			
LNF	4562			
FRY	1911			
MNQ	65			
MFG	2294			
CON	3029			
GEW	279			
HTR	424			
TCM	2015			
WRT	2023			
BRD	2655			
GSE				
OSE	179			
LS	53078			
LD(NON-SKILLED)				
PAD	6414	0.011	-0.395	2.086
OFC	5222	0.015	-0.543	1.852
CCR	4338	0.098	2.512	1.627
LNF	8724	-0.335	2.368	1.779
FRY	1796	-1.638	-6.763	4.299
MNQ	66	-0.432	10.49	-1.069
MFG	1206	0.82	12.663	2.291
CON	3620	-5.719	13.735	1.414
GEW	182	0.241	3.081	3.68
HTR	388	2.176	13.529	-7.557

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
TCM	1958	1.314	13.185	-0.774
WRT	258	-12.331	87.561	43.027
BRD	2660	0.027	3.1	5.303
GSE				
OSE	776	-0.001	1.229	5.348
LD (SKILLED)				
PAD		0.005	-0.174	-16.431
OFC		0.009	-0.322	-16.622
CCR		0.092	2.74	-16.807
LNF		-0.341	2.596	-16.683
FRY		-1.644	-6.555	-14.62
MNQ		-0.438	10.735	-19.014
MFG		0.814	12.913	-16.264
CON		-5.725	13.988	-16.981
GEW		0.235	3.31	-15.126
HTR		2.17	13.781	-24.325
TCM		1.308	13.436	-18.773
WRT		-12.337	87.978	17.084
BRD		0.021	3.329	-13.798
GSE		0.667	-4.441	-11.742
OSE		-0.007	1.454	-13.761
D. DEMAND				
CTH (H1)	24252	-1.087	8.498	2.723
CTH (H2)	21822	-0.238	3.09	-0.156
CH (H1)				
PAD	5533	-0.152	2.238	1.488
OFC	2697	-0.103	1.612	1.118
CCR	2910	-0.119	1.396	0.948
LNF	3958	-0.191	2.483	1.737
FRY	974	-1.061	-0.691	2.706
MNQ	66	0.031	0.993	1.331
MFG	5232	0.339	0.859	1.838
CON				
GEW	400	0.163	2.05	1.44
HTR	7	0.006	2	2.878
TCM	34	0.532	1.007	2.892
WRT	61	2.083	-5.701	-3.389
BRD	1111	-0.192	2.778	1.177
GSE	5	-0.185	2.447	-0.704
OSE	187	-0.11	1.545	1.252

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
CH (H2)				
PAD	3670	0.222	-5.025	-1.217
OFC	4264	0.1	-2.149	-0.52
CCR	3774	0.069	-2.059	-0.451
LNF	1953	0.15	-4.07	-0.819
FRY	2487	-0.377	-3.238	0.037
MNQ	44	0.186	-2.602	-0.539
MFG	3516	0.857	-7.573	-1.392
CON				
GEW	270	0.29	-6.703	-1.775
HTR	4	0.553	-7.75	-0.449
TCM	22	1.237	-8.584	-2.648
WRT	40	3.255	-14.217	-7.389
BRD	740	0.295	-7.097	-2.333
GSE	3	0.247	-5.985	-3.584
OSE	124	0.403	-8.132	-2.25
CTG	6570			
CG	6570	0.67		-11.784
C				
PAD	9203	-0.003	-0.659	0.409
OFC	6962	0.021	-0.692	0.115
CCR	6685	-0.012	-0.555	0.158
LNF	5911	-0.078	0.318	0.892
FRY	3460	-0.57	-2.521	0.788
MNQ	110	0.094	-0.452	0.58
MFG	8747	0.547	-2.53	0.54
CON				
GEW	670	0.02	-1.482	0.143
HTR	12	0.217	-1.75	1.598
TCM	56	0.809	-2.761	-0.499
WRT	101	2.547	-9.073	-4.973
BRD	1851	0.003	-1.17	-0.226
GSE	6578	0.669	-4.463	-11.771
OSE	310	0.095	-2.313	-0.144
IT				
IT (Private)	7462	-8.055	19.921	-0.162
IT (Public)	4986	-4.31	13.848	3.295

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
INV (Private)				
PAD				
OFC				
CCR				
LNF	188	-7.593	16.569	-0.52
FRY				
MNQ				
MFG	1754	-5.18	7.006	-1.231
CON	3786	-4.095	9.307	-0.419
GEW				
HTR				
TCM	982	-4.347	7.713	-5.211
WRT	458	2.347	-24.195	-23.221
BRD				
GSE				
OSE				
INV (Public)				
PAD				
OFC				
CCR				
LNF			16.569	
FRY				
MNQ				
MFG	839		7.006	
CON	2889		9.307	
GEW				
HTR				
TCM	748		7.713	
WRT	353		-24.195	
BRD				
GSE				
OSE				
ICNCI				
PAD	392	0.005	-0.174	0.283
OFC	358	0.009	-0.322	0.053
CCR	44	0.038	0.972	-0.112
LNF				
FRY	24	-0.565	-2.366	0.759
MNQ				
MFG	2250	0.223	3.329	-1.019
CON	324	-2.322	5.279	-0.238
GEW	165	0.078	1.018	-0.944

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
HTR	982	0.787	4.748	-4.24
TCM	1046	0.574	5.631	-3.616
WRT	7	-1.257	6.237	2.705
BRD	61	0.011	1.378	-0.838
GSE	632	0.667	-4.441	-11.742
OSE	551	-0.003	1.052	-2.753
IC				
PAD	3125	0.005	-0.174	0.283
OFC	2815	0.009	-0.322	0.053
CCR	2344	0.038	0.972	-0.112
LNF	1392	-0.168	1.182	0.444
FRY	1123	-0.565	-2.366	0.759
MNQ	260	-0.152	3.558	-774
MFG	6243	0.223	3.329	-1.019
CON	1128	-2.322	5.279	-0.238
GEW	817	0.078	1.018	-0.944
HTR	298	0.787	4.748	-4.24
TCM	3246	0.574	5.631	-3.616
WRT	2020	-1.257	6.237	2.705
BRD	887	0.011	1.378	-0.838
GSE	1641	0.667	-4.441	-11.742
OSE	650	-0.003	1.052	-2.753
E. FOREIGN TRADE				
M				
PAD	18	1.472	-6.959	1.154
OFC	58	2.101	-9.374	1.349
CCR	236	0.322	-2.751	0.107
LNF	156	0.771	-10.935	0.742
FRY				
MNQ	39	2.559	-7.001	1.173
MFG	5003	-0.717	-4.134	0.128
CON				
GEW	45	1.363	-3.894	0.207
HTR				
TCM	655	-2.017	-1.941	1.324
WRT	207	-8.171	28.109	22.756
BRD				
GSE				
OSE				

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
EX				
PAD	9	0.584	11.697	-1.092
OFC	13	0.64	11.089	-1.403
CCR	295	0.453	18.9	-1.092
LNF	176	0.212	14.401	0.156
FRY	5	0.185	10.969	-0.372
MNQ				
MFG	2130	2.509	10.583	-2.08
CON				
GEW				
HTR	1211	1.047	6.727	-3.726
TCM	2661	2.859	10.428	-6.649
WRT	918	5.878	-12.45	-14.513
BRD				
GSE				
OSE	19	0.604	7.139	-4.816
Q				
PAD	11106	0.007	-0.197	0.286
OFC	7908	0.025	-0.422	0.066
CCR	8561	0.032	0.208	-0.073
LNF	10525	-0.159	0.74	0.453
FRY	4100	-0.566	-2.383	0.76
MNQ	409	0.144	2.34	-0.561
MFG	15055	-0.373	-0.119	-0.516
CON	6675	-2.322	5.279	-0.238
GEW	1457	0.123	0.831	-0.903
HTR	765	0.421	1.811	-4.973
TCM	6092	-0.736	2.57	-1.782
WRT	3575	-3.622	11.576	7.65
BRD	5725	0.011	1.378	-0.838
GSE	6596	0.667	-4.441	-11.742
OSE	2092	-0.008	0.994	-2.734
TXS				
PAD	212	-0.715	4.095	2.029
OFC	273	-0.774	4.458	1.904
CCR	248	-0.338	4.437	0.787
LNF	101	-0.641	4.142	0.805
FRY	111	-1.496	-0.166	2.19
MNQ	1	-1.583	12.684	0.994
MFG	1469	-2.563	13.913	0.324
CON	85	-6.355	15.501	0.019
GEW	11	-0.578	7.018	1.959

Variables	Base Year	Percentage Change		
		Simulation 1 tm -25% tmi=0	Simulation 2 e+ 20%	Simulation 3 wq +20%
HTR	100	0.141	19.953	-5.515
TCM	-2	-2.21	19.913	0.315
WRT	2	-9.503	62.361	29.182
BRD	31	-0.62	4.681	3.141
GSE				
OSE	5	-1.006	9.997	0.785
TXM				
PAD	3	-23.896	11.65	1.154
OFC	10	-23.424	8.751	1.349
CCR	19	-24.758	16.699	0.107
LNF	11	-24.422	6.878	0.742
FRY				
MNQ	7	-23.081	11.587	1.173
MFG	549	-25.538	15.039	0.128
CON				
GEW	8	-23.978	15.327	0.207
HTR				
TCM	50	-26.513	17.67	1.324
WRT	9	-31.129	53.731	22.756
BRD				
GSE				
OSE				
TXE				
PAD				
OFC				
CCR	3	0.453	42.68	-1.092
LNF	2	0.212	37.281	0.156
FRY				
MNQ				
MFG	23	2.509	32.699	-2.08
CON				
GEW				
HTR	13	1.047	28.072	-3.726
TCM	29	2.859	32.513	-6.649
WRT	10	5.878	5.06	-14.513
BRD				
GSE				
OSE				
CAB	3229			

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Appendix-1

Consumption: Linear Expenditure System

The Stone-Geary Linear Expenditure System (LES) has been specified to estimate the consumption of various socio economic groups in the model. The LES is a complete set of consumer demand equations liner in total expenditure. The advantage of the LES is that it permits solutions of the general equilibrium system without computational iterations to determine consumer choice. For each socio-economic group, consumer demand is given by (omitting a group subscript)

(a) $C_i = \tau_i + \beta_i / P_i (Y - \sum_j P_j \tau_j)$

Where Y is total nominal expenditure for the group, τj are the committed expenditure or "subsistence minima" in physical terms, and βi are the marginal budget shares that determine the allocation of supernumerary income (i.e., expenditure required for purchasing the subsistence minima).

In the LES demand functions, only two parameters are required to be estimated: 1) floor consumption level and 2) marginal budget share. Once the average budget shares are obtained by dividing the consumption expenditures for sector i, PiCi, by the total consumption expenditure Y, both being given by the personal Consumption Expenditures Column of the Input-Output table, the above two parameters can be estimated in a variety of ways depending on the extent and quality of data. It is appropriate to econometrically estimate these parameters by using time series data for household expenditure. We have chosen to compute the parameters of LES for each group given exogenously specified average budget shares, income elasticities of demand and a parameter measuring the elasticity of marginal utility of income with respect to income (Frisch parameter, Frisch, 1959; Brown and Deaton , 1972) .

It can be shown that in the LES, the Frisch parameter is equal to the negative of the ratio of total expenditure and the super numerary expenditures, i.e., the Frisch parameter is given by:

(b) $\phi = -Y/ (Y-S)$ where $S = \sum_j P_j \tau_j$

Differentiation of Equation (a) shows that the expenditure elasticities of demand (Engel elasticities) are given by

$\varepsilon i = \beta i \, Y/Pi \, Ci = \beta i/\theta$

where $\theta i = PiCi/Y$, the average budget share of good i

Given the average budget shares and expenditure elasticities, the marginal budget shares are given by

(c) $\beta i = \varepsilon i \, \theta i$

Where εi are the expenditure elasicities and θi are average budget shares. Note that the marginal budget shares must sum to one, which is equivalent to imposing the condition known as Engel aggregation, that sum of the expenditure elasticities weighted by average budget shares must equal to one.

(d) $\sum \beta i = \sum \theta i \varepsilon i = 1$

The subsistence minima or floor consumption level τi are related to the other parameters according to the following equation:

(e) $\tau i = (Y/Pi) (\theta i + \beta i / \phi)$

For the present study , a Frisch parameter of -5.5 for non-poor households and -5 for poor households has been assumed on the basis of comparative estimates made for countries similar in economic development and industries activities as Nepal. Furthermore, Lluch, Powell and Williams (1977) show that the absolute value of this parameter falls with increases in per capita income.

With the value of Engel elasticities, Frisch parameter and average budget shares already available, the marginal budget shares and floor consumption level are computed using equations (c)-(e). Our estimates of the average budget shares, income elasticities, and Frisch parameters are based on the literature searches. Given the parameter of LES, the own and cross price elasticities of demand can be computed from the following equations:

(f) $\eta ii = -\varepsilon_i \ (P_i\tau_i /Y - 1/\phi)$

(g) $\eta ij = -\varepsilon_i \ (P_j \tau_j /Y) \ i \neq j$

Where ηii = own-price elasticity of good i

ηij = cross-price elasticity of good i.

Given the values opf Engel elasticities, Frisch parameter and floor consumption levels, the direct and cross-price elasticities are computed by equations (f) and (g), respectively.

Appendix-II

Import demand and Export Supply

The standard small-country assumption in simple commodity trade models is that the world price is fixed (i.e. that the country modeled is a price-taker) and that the domestic good is a perfect substitute for the internationally traded commodity, so that the law of one price holds. Given the high level of aggregation in an economy wide model, the assumption of perfect substitutability between domestic goods and international traded goods is not reasonable for most sectors. Thus, for importable, an alternative formulation, first proposed by Armington (1969) , is used.

First a composite commodity (Q_i) is defined as a CES function of imported goods (Mi) and domestically produced commodities (D_i). This can be formulated either as a maximization or as a minimization problem.

(1) Maximize $Q = b_i (\delta M^{-\rho} + (1-\delta) D^{-\rho})^{-1/\rho}$

subject to $P_i^C . Q = P^M M + P^D D$

or, (2) Minimize $P_i^C . Q = P^M M + P^D D$

subject to $Q = b_i (\delta M^{-\rho} + (1-\delta) D^{-\rho})^{-1/\rho}$

Given equation (2) each consumer chooses M_i and D_i in order to minimize the cost of obtaining a unit of Qi

(3) $L = P^M M + P^D D + l [Q - b \{d M^{-r} + (1-d) D^{-r}\}^{-1/r}]$

The solution to this cost minimization yields equation (4):

(4) $M/D = (\delta/1-\delta)^{\sigma} (P^D / P^M)^{\sigma}$

Equation (4) expresses the ratio of imported goods to domestically produced goods as a function of relative price of imported and domestically produced goods, where $\sigma_i = 1/(1+\rho_i)$ is the "trade substitution " elasticity. The larger the value for σ_i, the greater the sensitivity of the share of imports in total supply to price changes. In the limit, with σ_i equals to infinity (i.e.

imports and domestic goods are perfect substitute), P^D must equal P^M if imports and domestic production are both non-zero.

The Nepal's demand for imports is assumed to be to small to affect world prices, so the world price of imports expressed in foreign currency(P^{WM}) is fixed exogenously. The domestic price of imports is determined by $P_n^M=(1+tm_n)eP_n^{WM}$

Likewise, the domestic FOB price of exports (P_n^E) is equal to the exogenous world FOB price in US$ (P^{WE}) converted to domestic currency , less export taxes:

$P_n^E=eP_n^{WE}/(1+ te)$

Analogous to import goods, export goods and goods produced and consumed domestically may not be perfect substitute because of the relatively high level of aggregation in the model . Following Condon, Dahl and Devarajan (1987), a constant elasticity of transformation (CET) function between domestically and export markets.